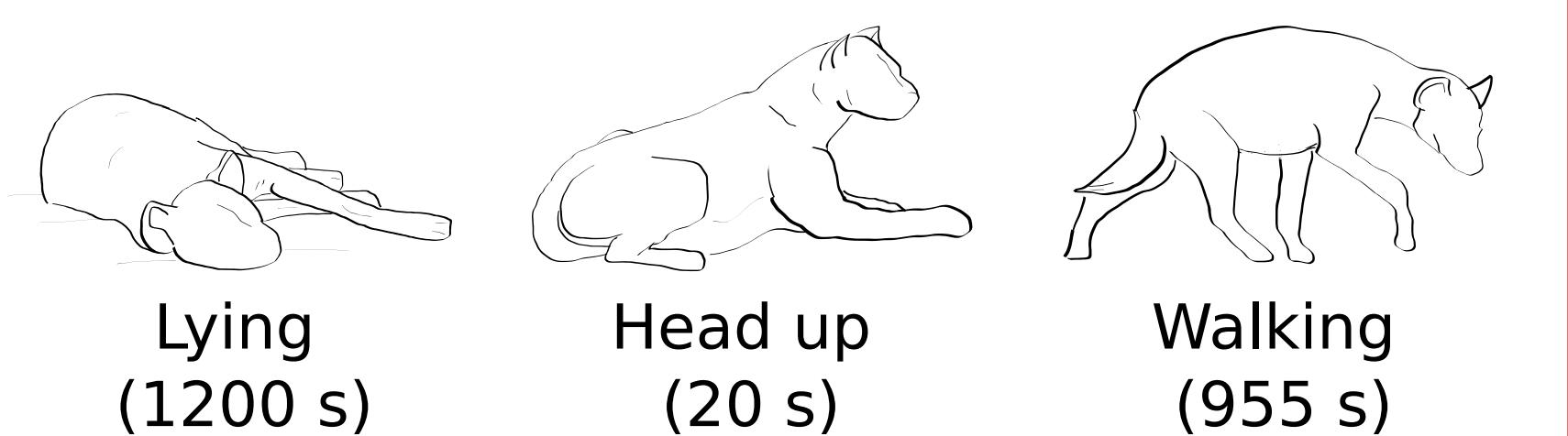
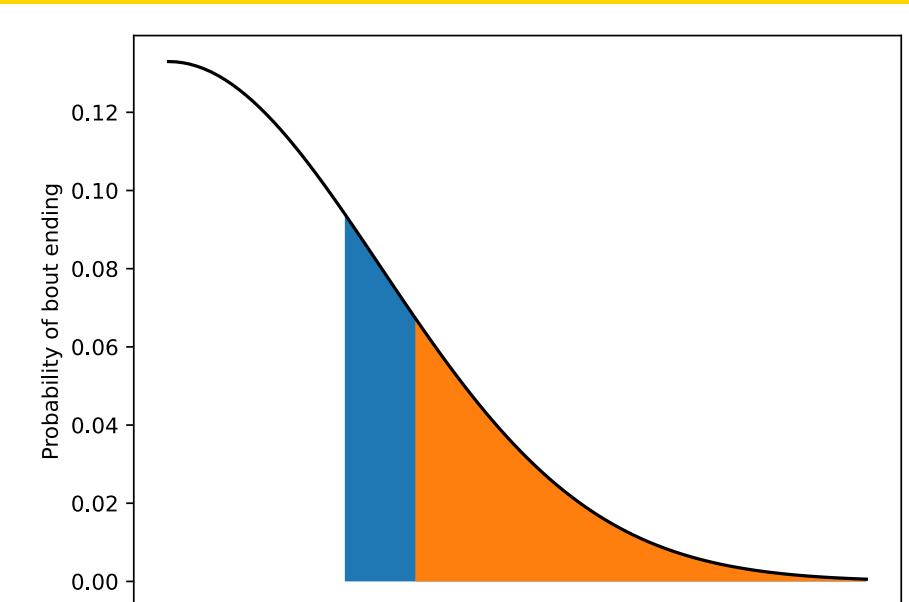


Animal behavior can be understood as behavioural sequences



Such behavioural sequences can then be analyzed to find algorithms animals use to make behavioural decisions.

Characterizing behavioral sequences



Hazard Function

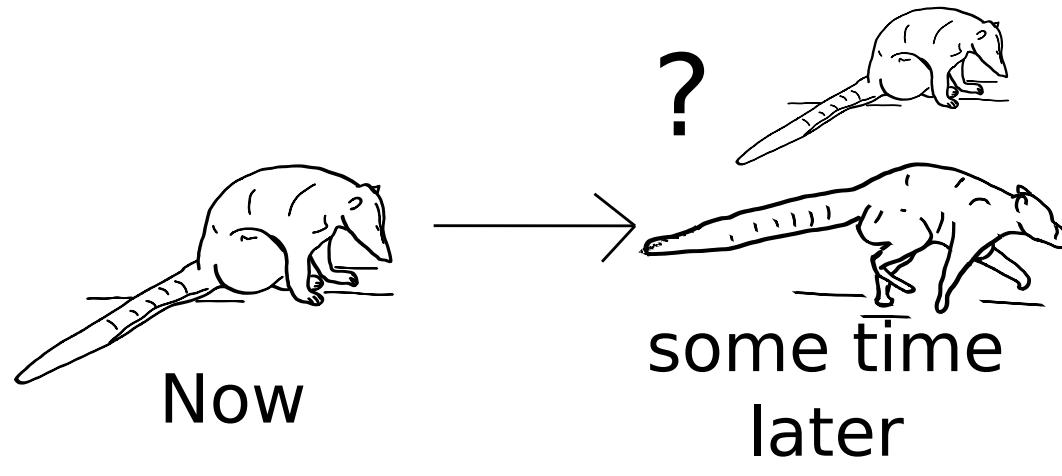
Instantaneous probability of a bout of behaviour ending

After an animal has started a bout of a behaviour, consider the probability that, in the next instant, it switches to a new behaviour. How does this probability vary with time as the animal keeps performing this behaviour?

Predictivity decay

Predicting future behavior based on current behaviour

Knowing the behaviour of an animal now lets us predict its future behaviour somewhat, but this ability to make predictions becomes weaker the farther into the future we attempt our behavioural predictions. How exactly does the predictability of behaviour decay?



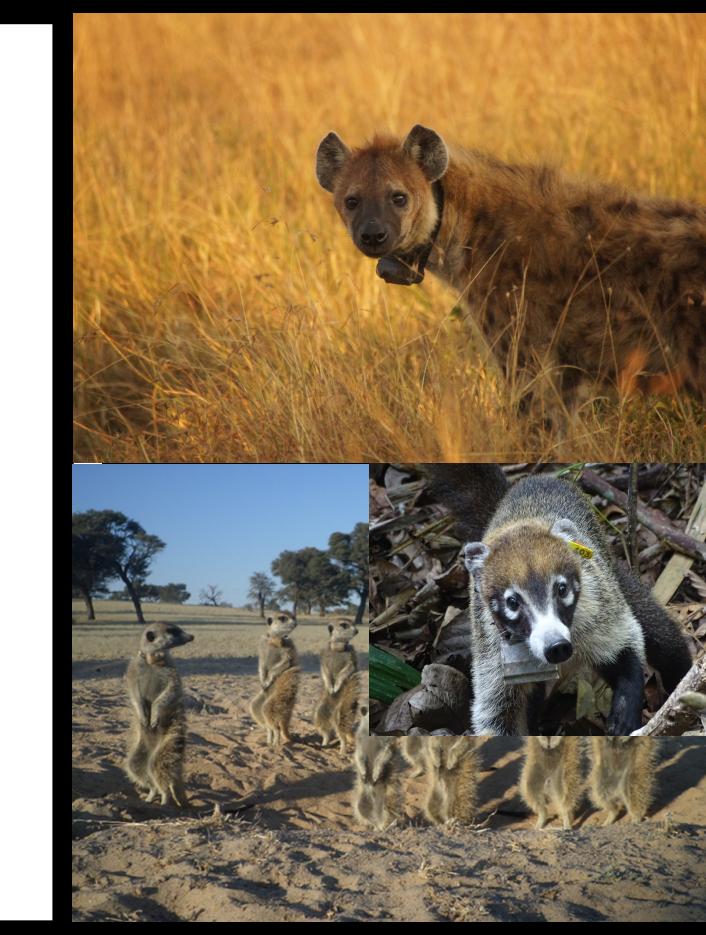
Question:

Are there general patterns in the temporal organisation of behaviour in the wild?

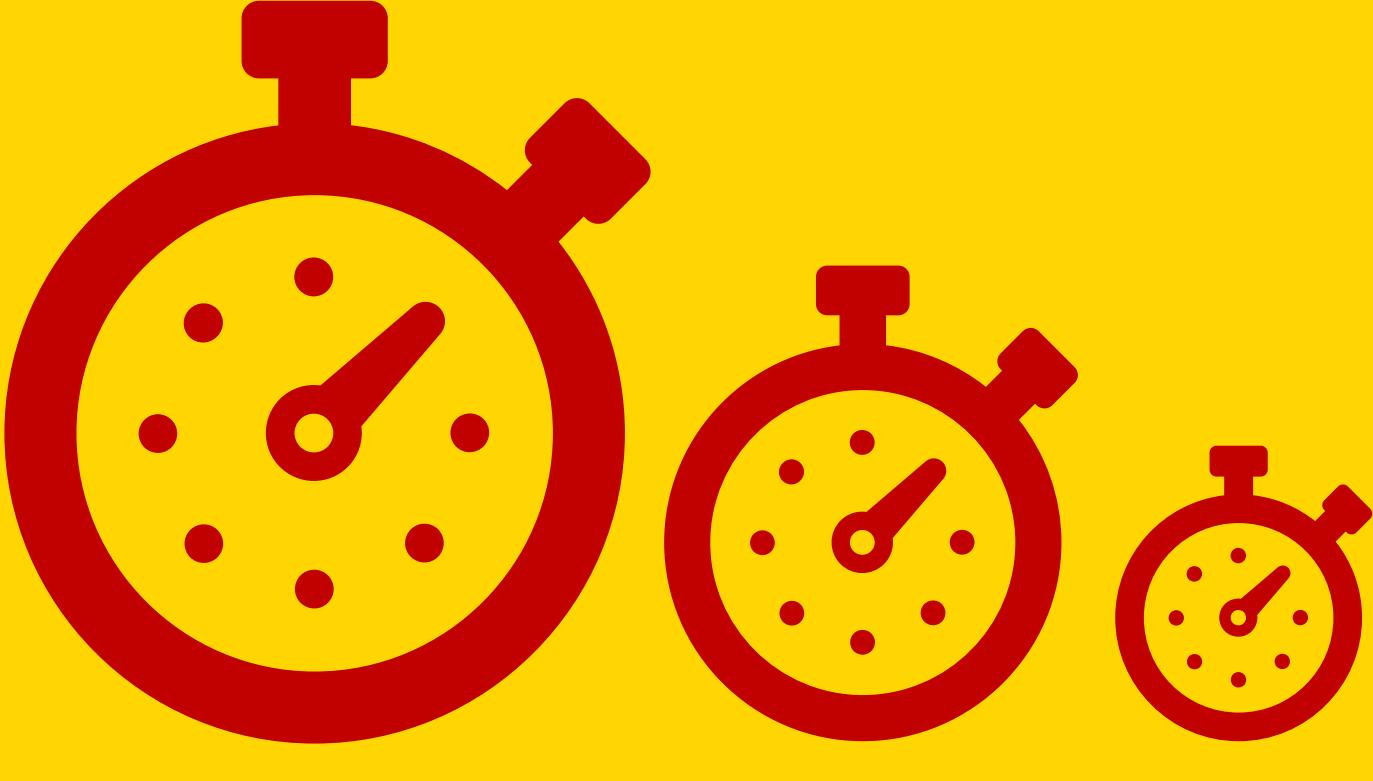
Since all animals use behaviour in response to face heterogeneity and unpredictability in the environment, there could be fundamental properties of behaviour that all behaving animals need to follow.

Approach:

Continuous accelerometry of individuals from 3 species, behaviour inferred with ML.



Explanation 2: Multi-timescale behavioral processes



Behavioral decisions can be taken at a variety of different timescales, thanks to the hierarchical nature of behavior or the variability of the environment. The interaction of these multiple timescales could lead to results like ours.

Deciphering behavioural algorithms:

Sequences of behavior show a common statistical structure across species

Pranav Minasandra^{a,b,c,d}, @PMinasandra, pminasandra.github.io

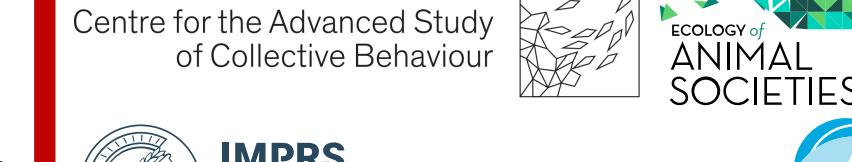
Emily M Grout^{a,b,c,d,e}, Katrina Brock^a, Margaret C Crofoot^{a,b,d,e}, Vlad Demartsev^{a,b,d,f}, Andrew S Gersick^g, Ben T Hirsch^{e,h}, Kay E Holekamp^{i,j}, Lily Johnson-Ulrich^{i,k}, Amlan Nayak^{a,b,l}, Jossué Ortega^{a,e}, Marie A Roch^m, Eli D Strauss^{a,b,d}, and Ariana Strandburg-Peshkin^{a,b,d,f}

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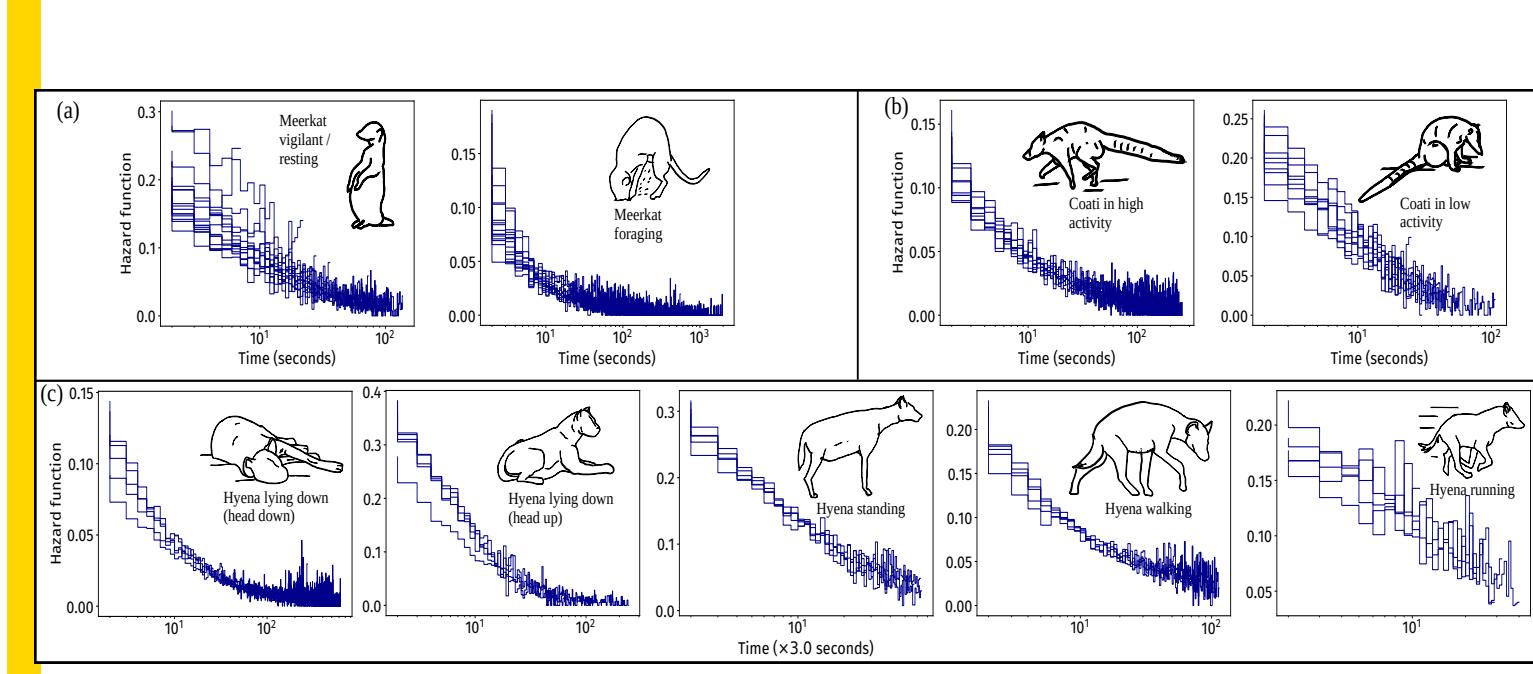
MAX PLANCK INSTITUTE
OF ANIMAL BEHAVIOR

Centre for the Advanced Study
of Collective Behaviour



INTERNATIONAL MAX PLANCK RESEARCH SCHOOL

Decreasing hazard functions in all behaviours



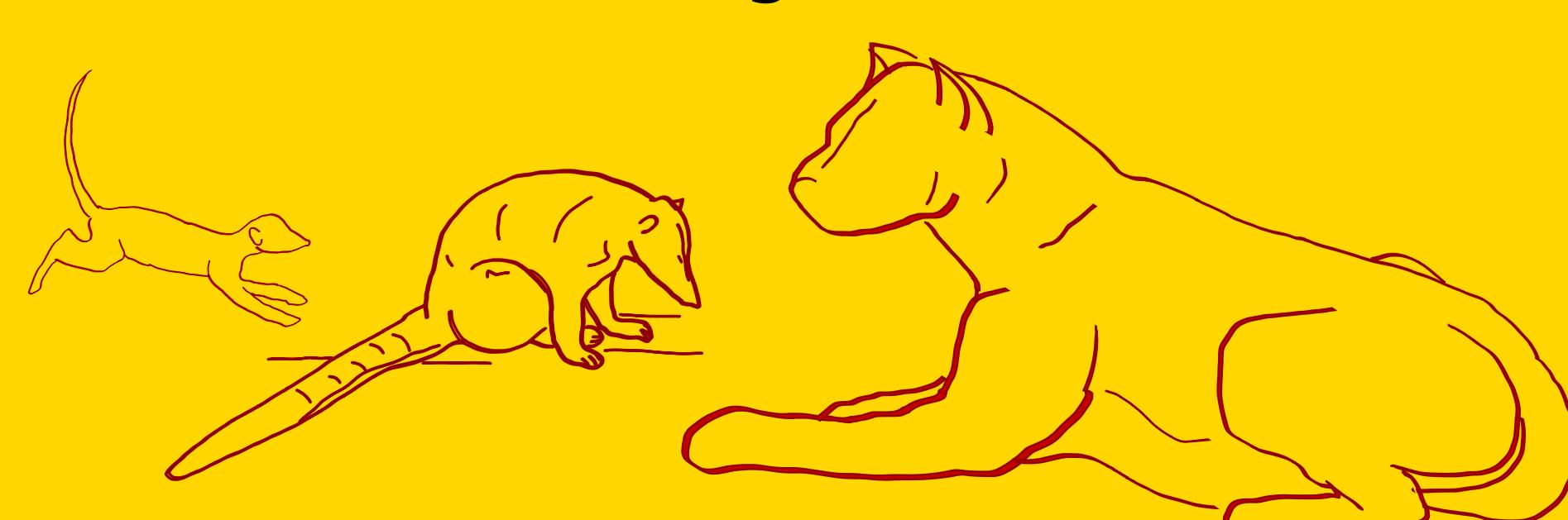
Golden Result #1: Long bouts of any behaviour tend to get even longer, in all individuals, behaviors, and species. Animals become less and less likely to switch to new behaviours.

Explanation 1: Behavioral algorithms have positive feedbacks



Positive feedbacks (internal, social, or environmental) in the behavioural algorithms can lead to the appearance of patterns like these.

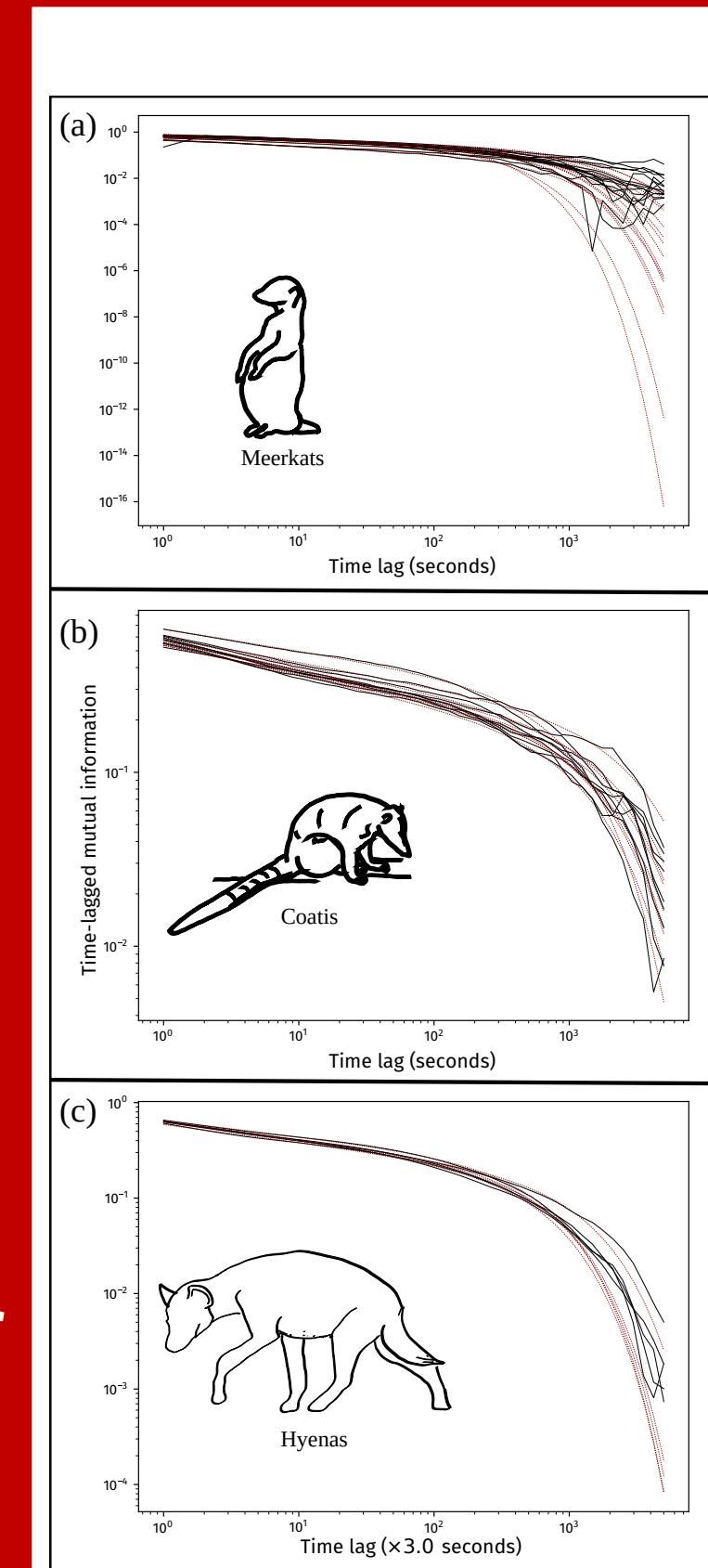
How widespread are these patterns in nature, and why do they occur?



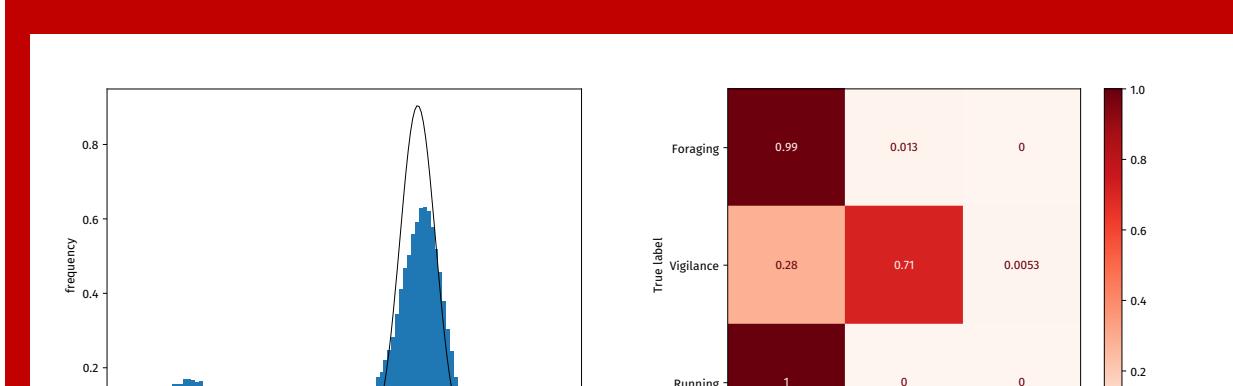
Our study species are fairly different, so these results are already surprising. Further studies are needed to understand how widespread these phenomena are. We propose two overarching explanations for these phenomena.

Consistent predictivity decay

Golden Result #2: The influence of present behaviour is transmitted into the future in similar ways. This points to similarities in animal behavioural algorithms

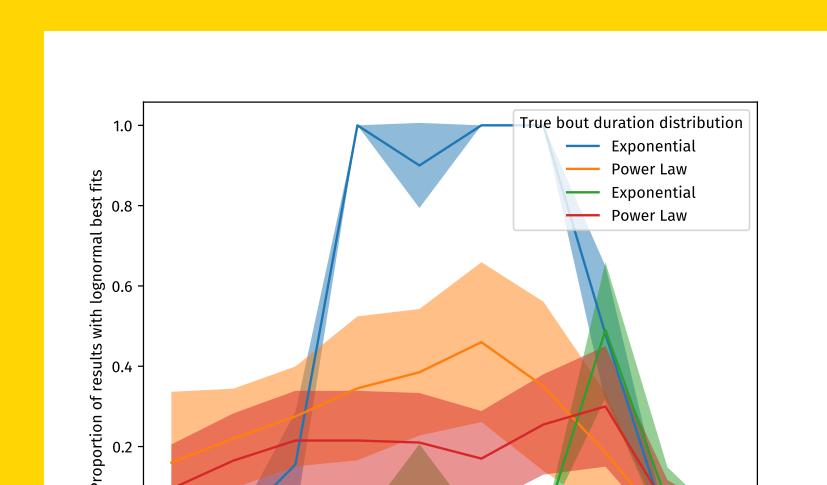


Inferring behavior from accelerometers



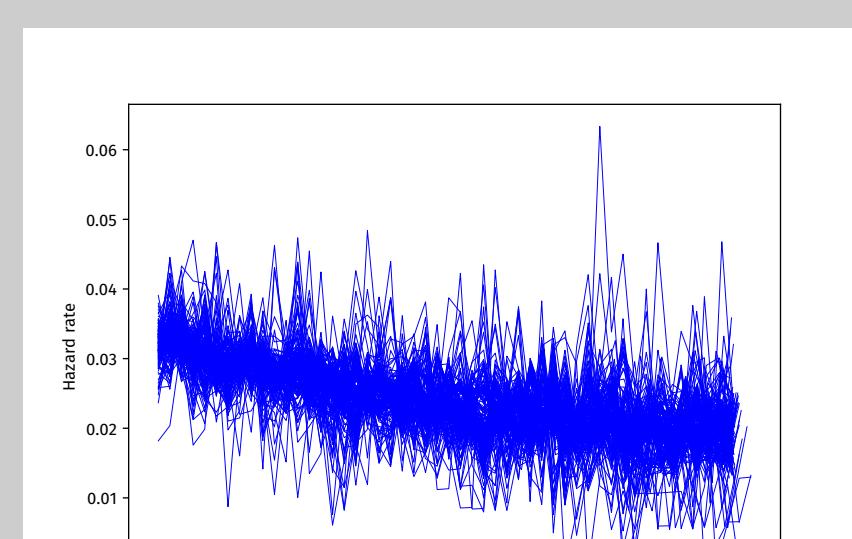
We used unsupervised and supervised machine learning approaches and video data of animal behaviour to obtain long behavioural sequences.

Effect of classification error



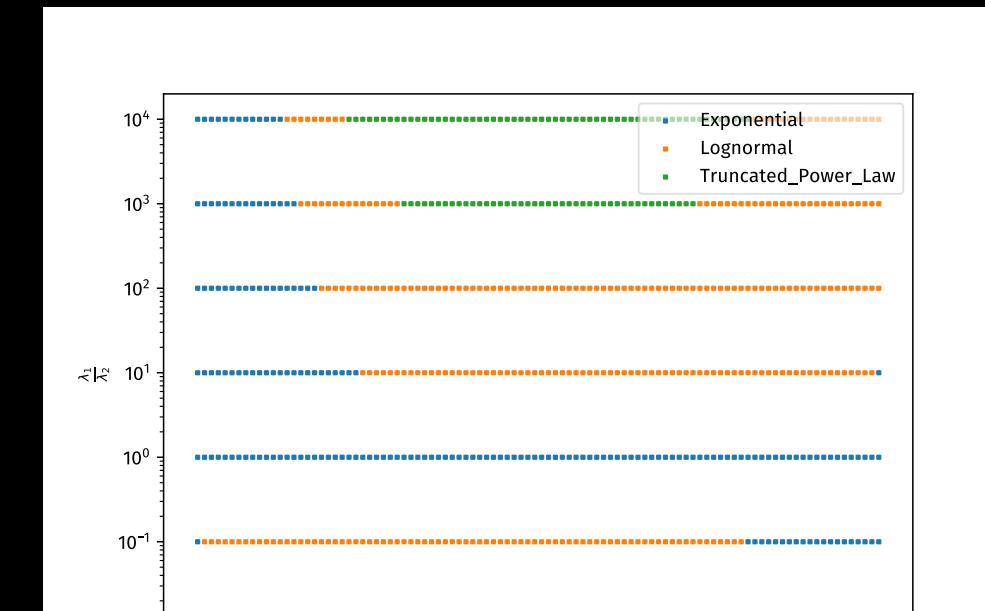
Classifier error overall tends to shorten bout lengths, actually reducing the strength of effects like those described here. The actual effect of a classifier on behavioural bouts is complex. We explore this in our manuscript through several simulations.

Social interactions and reinforcement



An element of social copying of behaviour is, alone, sufficient to generate a decreasing hazard function. This underscores the point that positive feedback could be an explanation for this phenomenon.

Mixtures of time-scales



Specific timescales need to intersect to create the apparent scale invariance and behavioral structure seen here. We explore this further through a simulation.

